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MS APPEAL BRIEF - PATENTS
PATENT
4450-160P

IN THE U.S. PATENT AND TRADEMARK OFFICE

In re application of		Before the Board of Appeals	
Michael G. Taylor		Appeal No.:	
Appl. No.:	09/697,703	Group:	2633
Filed:	October 27, 2000	Examiner:	A. BELLO
Conf.:	4821		
For:	POLARIZATION MODE DISPERSION COMPENSATING APPARATUS, SYSTEM AND METHOD		

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APPEAL BRIEF TRANSMITTAL FORM

MS APPEAL BRIEF - PATENTS
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

June 30, 2004

Sir:

Transmitted herewith is an Appeal Brief (in triplicate) on behalf of the Appellants in connection with the above-identified application.

☐ The enclosed document is being transmitted via the Certificate of Mailing provisions of 37 C.F.R. § 1.8.

A Notice of Appeal was filed on April 6, 2004.

☐ Applicant claims small entity status in accordance with 37 C.F.R. § 1.27

The fee has been calculated as shown below:

☒ Extension of time fee pursuant to 37 C.F.R. §§ 1.17 and 1.136(a) - $110.00.

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Respectfully submitted,

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MRC/HNS/jm
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Attachment(s)

(Rev. 02/08/2004)

Appl No: 09/697,703
Attorney Docket: 4450-0160P

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants:	Michael G. TAYLOR	Appeal No.:
Appl No:	09/697,703	Art Unit: 2633
Filed:	October 27, 2000	Examiner: A. BELLO
For:	POLARIZATION MODE DISPERSION COMPENSATING APPARATUS, SYSTEM AND METHOD	

APPEAL BRIEF ON BEHALF OF APPELLANT: Michael G. Taylor

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

June 30, 2004

Sir:

This appeal is from the decision of the Examiner dated November 6, 2003 finally rejecting claims 1-23, which are reproduced as an Appendix to this brief.

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I. Real Party in Interest

The real party in interest is CIENA Corporation of Linthicum, Maryland.

II. Related Appeals and Interferences

There are no other appeals or interferences that will directly affect or be directly affected by or have a bearing on the Board's decision in this appeal.

III. Status of Claims

Claims 1-23 are pending in this application and are subject of this appeal.

IV. Status of Amendments

No amendment has been submitted after final.

V. Summary of the Invention

The present invention relates to polarization mode dispersion compensating apparatuses, systems and methods. Polarization mode dispersion (PMD) is a problem caused by the undesired, residual birefringent properties of optical fibers.

PMD causes the two principal states of polarization (PSP) to propagate along an optical fiber at different rates. The polarization of an optical signal may be expressed in terms of two components (the so-called "principal states of polarization"). The two PSPs each experience different propagation delays as they propagate down a length of optical fiber due to the residual birefringence of the fiber. The result of the time delay (τ) between the two PSPs (also referred to as differential group delay (DGD)) is that the signal is distorted. The time delay (τ) may be on the order of 10-20 ps for a 100 km fiber

More accurately, DGD exhibits a Gaussian distribution. DGD values, such as the 10-20 ps per 100 km fiber mentioned above, are usually a mean value of this Gaussian distribution. However, the Gaussian distribution means that there is a likelihood of a DGD value much larger than the mean. Such large DGD values can cause optical signal pulses (composed of both PSPs) to broaden to such an extent that intersymbol interference occurs and the bit error rate (BER) rises.

In addition, higher data rates and longer transmission distances make even small PMD values a more significant problem

than in the past. For example, at 10 Gb/s rate, only 100 ps separates each pulse. Thus, a 50 ps PMD could easily cause a bit error. The progression to 40 Gb/s and higher makes PMD compensation an important problem to solve.

Exacerbating these problems is the fact that PMD varies with time, fiber temperature, and fiber stress. For example, a technician moving a fiber could stress the fiber and induce a fluctuating PMD. Temperature cycling will can also cause a fluctuating PMD. Thus, a PMD compensator having a fixed amount of counter-PMD is unlikely to adequately offset the time-varying PMD.

In an aspect of the present invention, the PMD of an input signal is corrected by controlling a polarization mode dispersion compensator having a variable PMD so as to generate a PMD vector of equal magnitude but opposite direction to the PMD vector of the input signal. Mathematically, the input signal has a PMD that may be expressed as a vector on the Poincare sphere having an associated magnitude and direction (θ, ϕ). Generally speaking, the polarization mode dispersion compensator is controlled to generate a counter-PMD vector of equal magnitude and opposing direction $(-\theta,-\phi)$ thereto.

In Figure 1 of the present application, an embodiment of a polarization mode dispersion compensator 100 according to the present invention is illustrated. The PMD compensator 100 counters or opposes the PMD vector of the input signal 1. In this particular embodiment, two polarization mode dispersion elements (PMDE) 20 and 40 are utilized to provide opposing PMD vectors. Each PMDE 20, 40 has an associated PMD magnitude T.[1]

Further, the PMDEs 20, 40 have a relative angle θ between the polarization mode dispersions of the PMDEs 20, 40. To control this angle θ, a variable retarder 30 is optically placed between the two PMDEs 20, 40. The principle polarization axes of the variable retarder 30 are preferably at 45 degrees to the polarization of the PMDEs (indicated by axes above each element). As the name suggests, the principle axis of the variable retarder 30 is variable (indicated by an arc having two arrows).

The variable retarder 30 varies the angle θ between the PMD vectors of the PMDEs 20, 40 to compensate for the differential group delay between the two polarization components of the input signal 1. Optionally, more PMDEs or PMD compensators 100 may be

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[1] The PMDE magnitudes of the two PMDEs need not be the same.

combined, for example in a cascade fashion, to provide greater PMD compensation.

To complete the circuit, a polarization controller 10 is optically coupled to an input port 5 to receive the input signal 1. The polarization controller 10 varies the orientation of the input signal's polarization axes to align with and opposed to the polarization axes of the PMDEs 20, 40.

In Figure 3 of the present application, an embodiment of an apparatus to compensate for polarization mode dispersion according to the present invention is illustrated. Note that apparatus of Figure 3 includes all elements of Figure 1 - the polarization controller 10, PMDEs 20 and 40, and variable retarder 30. In other words, the apparatus of Figure 3 includes the PMD compensator 100.

In this embodiment, the optical output of the PMD compensator 100, that is the output of the PMDE 40, is connected to an optical tap 95. The optical output signal 99 output from the PMD compensator 100 serves (via the optical tap 95) as the output of the entire apparatus.

The output of the PMD compensator 100 is optically coupled (also via the optical tap 95) to the polarimeter 60. In this

embodiment, the polarimeter 60 includes three polarizers 52, 54, and 56 each receiving a portion of the output signal 99. The polarizers 52, 54, and 56 have different polarizations to polarize the light incident thereon. For example, the three polarizations may be a circular polarization, polarization at a first angle, and polarization at a second angle different from the first angle.[2]

The polarized lights from each of the polarizers impinge on corresponding detectors 62, 64, and 66. Each of the polarization states (P1, P2, and P3) can be represented as detected amounts (d1, d2, and d3).

If further control is desired, the source of the input signal 1 may be dithered or otherwise varied by a small amount. Dithering the source permits the PMD to be observed. Given that a signal passes through a path having PMD, the output state of polarization changes as a function of wavelength. This phenomenon is exploited by intentionally varying the source wavelength and observing the resulting changes to the state of polarization. When the net PMD of the communication system plus the compensator is small, this results in a small change in a

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[2] The polarization of the polarizers are not limited to this particular arrangement. Generally, polarizers to detect polarization at any three degrees of freedom is sufficient.

the dither observed by the polarimeter 60. In other words, when the PMD compensator is set correctly, the observed dither in the SOP by polarimeter 60 is small.

The apparatus of Figure 3 further includes a controller 70, which receives the detected polarized components from the detectors, 62, 64, 66. The controller 70 can recover the content of the dither (frequency of the dither). In this way, the source need not separately transmit the dither content to the controller 70.

Controller 70 utilizes the detected polarized components from the detectors 62, 64, 66 to control the PMD compensator 100 so as to minimize PMD of the input signal plus the PMD of the apparatus. The controller 70 uses the detected polarized dither to control the variable retarder 30 and the polarization controller 10 to minimize sum of squares of the detected polarized components, i.e. $\min[(d1)^2 + (d2)^2 + (d3)^2]$.

In Figure 4 of the present application, another embodiment of an apparatus to compensate for polarization mode dispersion according to the present invention is illustrated. A difference between the embodiments of Figures 3 and 4 is that the embodiment illustrated in Figure 4 includes a Q detector 80 in place of the

polarimeter 60. The embodiment of Figure 4 may also includes an OE converter (optical-to-electrical) 45 if the Q detector 80 operates on electrical signals.

The Q detector 80 outputs a signal Q value as an indication of a quality of the optical output signal 99. In this particular embodiment, the Q value is a quantitative measure of the signal pulse sharpness of the optical output signal 99 - sharper the pulse, better the quality.

The controller 70 in the embodiment of Figure 4 now controls the polarization controller 10 and the variable retarder 30 to maximize the Q value. A maximized Q corresponds to sharp pulse edge transitions, which indicates that PMD of the input signal 1 has been minimized.

VI. Issues

The following are the issues presented for appeal:

- Whether claims 1-4, 9, 12-16, 19, 21, and 23 [3] are properly rejected under 35 U.S.C. §103(a) as being

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[3] The Examiner included claim 22 as being obvious over the combination of Bulow and Cao. *See Final Office Action, page 2, item 2, first paragraph.* However, claim 22 depends from claim 10 and claim 10 is rejected based on Bulow, Cao, and Bergano references. Therefore, Appellant includes claim 22 as also being rejected based on Bulow, Cao, and Bergano.

unpatentable over Bulow (U.S. Patent No. 5,793,511) in view Cao (U.S. Patent No. 6,130,766);

- Whether claims 5-9, 17, 18, and 20 are properly rejected under 35 U.S.C. §103(a) as being unpatentable over Bulow in view of Cao and further in view of Fishman (U.S. Patent No. 5,930,414); and
- Whether claims 10, 11, and 22 are rejected under 35 U.S.C. §103(a) as being unpatentable over Bulow in view of Cao and further in view of Bergano (U.S. Patent No. 6,134,033).

VII. Grouping of Claims

A. First Group

Claims of the First Group include claims 1-18 and 21-23. Claims 1 and 12 are independent and all other claims of the First Group depend from claim 1 or 12 directly or indirectly. The claims of the First Group stand or fall together.

B. Second Group

Claims of the Second Group include claims 19 and 20. Claim 19 is independent and claim 20 depends from claim 19. The claims of the Second Group stand or fall together.

VIII. Arguments

A. **First Group - Bulow and Cao Cannot Teach Or Suggest The Elements Of The Independent Claims 1 or 12**

For a Section 103 rejection to be valid, the Examiner must establish a *prima facie* case of obviousness. *See M.P.E.P. 2142.* One requirement to establish a *prima facie* case of obviousness is that the prior art references must teach or suggest **all claim limitations**. *Emphasis added; see M.P.E.P. 2142; M.P.E.P. 706.02(j).* Thus, if a cited reference fails to teach or suggest one or more elements, the rejection is improper and must be withdrawn.

In the Office Actions, the Examiner exclusively relies upon Bulow to teach the polarization mode dispersion compensator (except for dithering of input optical signal)[4], the polarimeter,

[4] The Examiner relies upon Cao to teach dithering of optical signals. *See November 6, 2004 Final Office Action, page 3, lines 3-5.*

and the controller all as claimed. *See November 6, 2004 Final Office Action, page 3, line 4 of item 2 - page 4, line 8.*

As will be demonstrated below, Bulow cannot be relied upon to teach or suggest at least the above-noted elements of the independent claim 1 and cannot be relied upon to teach or suggest similar elements of the independent claim 12.[5] Bulow is directed towards equalizing PMD-induced interference in optical signals. An optical receiver as disclosed in Bulow consists of the following three parts - a splitting facility 1.1, an equalizing circuit 1.2, and a control facility 1.3. *See Bulow, Figure 1.*

Bulow discloses that the splitting facility 1.1 receives as input an optical signal S from the optical fiber network and splits the signal S into two electrical components S_- and S_+. *See Bulow, column 2, lines 53-58.* The component signal S_- represents the optical signal S propagating in one polarized mode (e.g. TE mode) and the component signal S_+ represents the

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[5] Appellant notes that claim 12 is identified as being rejected starting on Final Office Action, page 3, line 15, and is grouped with claims 3, 13, and 14. However, this appears to be in error since this particular portion of the Final Office Action discusses features specific to claims 3 and 13 (first, second, and third polarizers) - the features of which are absent in claim 12. Appellant assumes that the Examiner rejects independent claim 12 on a basis similar to the basis he used to reject independent claim 1.

optical signal S propagating in another polarized mode (e.g. TM mode), where S_- and S_+ are orthogonal to each other. *See Bulow, column 1, lines 17-25; column 3, lines 34-43.*

The equalizing circuit 1.2 receives the electrical component signals S_- and S_+ and generates corresponding logic signals Z_- and Z_+. *See Bulow, column 3, lines 52-65.* The signals Z_- and Z_+ represent binary logic values (0 or 1) of the signals S_- and S_+, respectively, and are also electrical. *See Bulow, column 4, lines 44-48.* Due to the differential propagations of the two orthogonal components (TE, TM) of the optical signal S, the logic signals Z_- and Z_+ are fed to delays line 2.2, 2.4, respectively, to equalize the time difference of the TE and TM components. *See Bulow, column 4, lines 22-27.*

The data signal D output from the equalizing circuit 1.2 is the output of the whole apparatus (the optical receiver). *See Bulow, column 3, lines 5-7.* The data signal D is either Z_- or Z_+, and is dependent on which of the two electrical components S_- or S_+ determined to have a better signal quality. *See Bulow, column 4, lines 10-15.* Note that the data signal D, i.e., the output of the apparatus, is **electrical**.

The equalizing circuit 1.2 also outputs a quality signal Q (also electrical), which is used for optimization of the optical receiver. The quality signal Q is determined by evaluating signals Z_-, Z_+, Y_-, and Y_+. *See Bulow, column 4, lines 65-67.* Bulow discloses that signals Y_- and Y_+ indicate the error rates of the component signals S_- and S_+, respectively. *See Bulow, column 4, lines 50-53.* Indeed, the equalizing circuit determines the quality of the component signals S_- and S_+ based on the error rate signals Y_- and Y_+ when the decision is made to either use the signal Z_- or Z_+ as the data signal D. Thus, the quality signal Q, at best, represents a measure of error rates of the polarization components TE and TM of the optical signal S.

A.1. Bulow Cannot Teach or Suggest the Polarization Mode Dispersion Compensator as Claimed

Independent claim 1 recites, in part, "a polarization mode dispersion compensator … an **output** of said polarization mode dispersion compensator **serving as an output of the** polarization mode dispersion compensating **apparatus**." *Emphasis added.* Also, claim 12 recites, in part, "compensating … wherein an optical signal **output** of a polarization mode dispersion compensator

serves as an output of a polarization mode dispersion compensating **apparatus.**" Bulow cannot be relied upon to teach or suggest this feature.

In the Office Actions, the Examiner asserts that the polarization mode dispersion compensator is taught by the optical polarization controller 1.7 as shown in Figure 1 of Bulow. *See April 1, 2004 Final Office Action, page 2, item 2, second paragraph.* This is without merit.

It is clear from Figure 1.7 that the output of the polarization controller 1.7 is only connected to the optical splitter 1.6. As noted above, the output of the entire optical receiver device of Bulow is the data signal D output from the equalizing circuit 1.2. Clearly, D is **not** output from the polarization controller 1.7 which would be required if the polarization controller 1.7 is truly equivalent to the polarization mode dispersion compensator as claimed as the Examiner asserts.

Therefore, Bulow cannot be relied upon to teach or suggest the polarization mode compensator where the output of the polarization mode dispersion compensator serves as an output of the polarization mode dispersion compensating apparatus as recited in claims 1 and 12.

A.2. Examiner's "Derivative" Test Unreasonable

In response to the argument that the polarization controller's output is not the output of the apparatus, the Examiner makes the following statement:

> As seen in the figures the output (D) of the apparatus (Figure 1) is a direct **derivative** of the signals (S) which are direct derivatives of the output of the polarization controller, thus the output of the apparatus (D) is, given the broadest reasonable interpretation, the output of the polarization controller. *Emphasis added; See Examiner's Advisory Action dated April 1, 2004.*

Under the Examiner's reasoning, if there is any connection between a first signal and a second signal that is down the chain of intervening elements from the first signal, the second signal is the output of the of element that produced the first signal, regardless of how far removed the second signal is from the first signal. This is an extremely **unreasonable** and **strained** interpretation.

Under the Examiner's reasoning, then the data signal D is also the output of the first device prior to the polarization controller 1.7 (unseen in Figure 1 of Bulow) since D is a

derivative[6] of the signal S and the first device produced the optical signal S. The data signal D is also the output of the second device prior to the controller 1.7 that produced the output used as the input to the first device that produced the optical signal S since D is a **derivative** of the output of the second element.

Taken further, the signal D is the output of the third device, the fourth, and so on. Thus, under the Examiner's reasoning, there is no end to the derivative test. This is clearly unreasonable and the Examiner's reasoning cannot be used as a basis of rejection.

Therefore, Bulow cannot be relied upon to teach or suggest the polarization mode compensator where the output of the polarization mode dispersion compensator serves as an output of the polarization mode dispersion compensating apparatus as recited in claims 1 and 12.

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[6] Appellant realizes that there is no "directness" between the output of the polarization controller 1.7 and the data signal D output from equalization circuit 1.2 since there are multiple intervening elements performing multiple conversion processes therebetween. Therefore, Appellant will simply use the term "derivative" to more accurately reflect the Examiner's position.

A.3. Bulow's Output D Cannot Teach the Output As Claimed

Even if, for the sake of argument, that the data signal D is the output of polarization controller 1.7, the above-recited element still cannot be met. Claim 1 also recites, in part, "a polarimeter **optically coupled** to the output of said polarization mode dispersion compensator".

As recited, the output of the polarization mode dispersion compensator serves as the output of the PMD apparatus and the output of the polarization mode dispersion compensator is optically coupled to the polarimeter. Taken together, it is clear that the output of the entire apparatus as claimed in claim 1 - the PMD apparatus - is **optical.**

Claim 12 recites, in part, "polarizing the **optical signal** output from the variable polarization mode dispersion compensator."

In both claims 1 and 12, the output is **optical** which is clearly distinguishable from Bulow's data signal D, which is **electrical.** Therefore, Bulow cannot be relied upon to teach or suggest the polarization mode compensator where the output of the polarization mode dispersion compensator serves as an output of

the polarization mode dispersion compensating apparatus as recited in claims 1 and 12.

A.4. Bulow Cannot Teach or Suggest the Polarimeter as Claimed

Independent claim 1 recites, in part, "a polarimeter optically coupled to the output of said polarization mode dispersion compensator and outputting electrical signals **representing polarization states** of the **output** of said polarization mode dispersion compensator." Claim 12 recites, in part, "polarizing the optical signal **output** from the variable polarization mode dispersion compensator to generate **polarized component optical signals**" and ""detecting polarized component optical signals to generate **detection signals.**" *Emphasis added.* Bulow cannot be relied upon to teach or suggest these features.

In the Office Actions, the Examiner asserts that the polarimeter is taught by the TE and TM optical polarizers 1.4 and 1.5, photo diodes 1.8 and 1.9, and the equalizing circuit 1.2 as shown in Figure 1 of Bulow. *See April 1, 2004 Final Office Action, page 2, item 2, second paragraph.* This is also without merit.

Claim 1 also recites, in part, "a controller operatively coupled to said polarimeter ... said controller receiving the electrical signals from said polarimeter" and claim 12 recites, in part, "controlling said compensating step according to the detection signals." The Examiner asserts that the controller is taught by the control facility 1.3 as shown in Figure 1 of Bulow. *See April 1, 2004 Final Office Action, page 2, item 2, second paragraph.*

In Figure 1 of Bulow, it is noted that the control facility 1.3 receives only the quality signal Q from the equalizing circuit 1.2. Thus, the Examiner is asserting that the quality signal Q teaches the signals representing polarization states (claim 1) and detection signals (claim 12) as recited.

However, as noted above, the quality signal Q is, at best, a measure of error rates of the components of the input optical signal S, i.e. error rates of S_- and S_+. There is no disclosure in Bulow otherwise.

The electrical signal output from the polarimeter as claimed in claim 1 and the quality signal Q of the equalizing circuit 1.2 of Bulow are clearly distinguishable. Simply put, the measurements are different. In claim, the polarimeter

outputs signals that represent **polarization states** of an optical signal. This is to be contrasted with the signal Q of the equalizing circuit 1.2 of Bulow which represents the **error rates** of an optical signal. The two - that is the polarization states and error rates - simply cannot be equated with each other.

For similar reasons, the output as recited in claim 12 and the quality signal Q of the equalizing circuit 1.2 of Bulow are distinguishable as well. In claim 12 as recited, the detection signals represent **detected polarized component optical signals** of an optical signal. This is to be contrasted with the signal Q of the equalizing circuit 1.2 of Bulow which represents the **error rates** of an optical signal. The two - that is the detected polarized component optical signals and error rates - simply cannot be equated with each other.

Also, in claim 1, the polarimeter measures polarization states of the signal **output** from the PMD apparatus, and in claim 12, the method included detecting polarization component signals of the optical signal that is **output**. In a clear contrast to claim 1 and 12, the equalizing circuit 1.2 of Bulow measures the quality of the signal **input** to the optical receiver.

Simply put, Bulow cannot be relied upon to teach or suggest a polarimeter outputting electrical signals representing polarization states of the output of the polarization mode dispersion compensator as featured in claim 1 since the type of measurement and the particular signal measured are completely different between the claim 1 and Bulow.

For similar reasons, Bulow cannot be relied upon to teach or suggest polarizing the optical signal output from the variable polarization mode dispersion compensator to generate polarized component optical signals as featured in claim 12.

A.5. Bulow Cannot Teach or Suggest the Controller as Claimed

Independent claim 1 recites, in part, "a controller operatively coupled to said polarimeter and said polarization mode compensator, said controller **receiving the electrical signals from said polarimeter**, said controller controlling said polarization mode dispersion compensator according to the electrical signal to compensate for the polarization mode dispersion of the input optical signal." Similarly, claim 12

recites, in part, "controlling said compensating step according to the **detection signals.**"

In general, the operation of the controller as claimed are based on the input signals to the controller. It has been demonstrated above that the quality signal Q input to the control facility 1.3 as disclosed in Bulow is completely different from either of the electrical signals output from the polarimeter as claimed in claim 1 or the detection signals as claimed in claim 12.

Then it logically follows that Bulow cannot be relied upon to teach or suggest the controller receiving the electrical signals from the polarimeter as claimed in claim 1 since the information received by the control facility 1.3 of Bulow is completely different from the information included in the electrical signals from the polarimeter.

Similarly, Bulow cannot be relied upon to teach or suggest controlling the compensating step according to the detection signals as claimed in claim 12.

A.6. Bulow and Cao Teach Away from Each Other; Modifying Bulow or Cao Renders Either Unsatisfactory for Its Intended Purpose

It is noted that Cao has not been relied upon to cure the above-noted deficiencies of Bulow. Indeed, the Bulow and Cao cannot be combined since they teach away from each other. Also, modifying one with the other as suggested by the Examiner would render either unsatisfactory for its intended purpose.

In this instance, Bulow specifically states equalization of the polarization mode dispersion takes place ***exclusively in the electrical part*** of the device. *See column 3, lines 44-49.* On the other hand, Cao states correcting for polarization mode dispersion **optically.** More specifically, Cao states that the DSP control unit 30 generates a control signal to the polarization controller 22 to reorient and align the linearly polarized components of the received optical signals to the axes of the polarization beam splitter 24. *See Cao, column 5, lines 50-64.*

Since Bulow teaches equalizing exclusively in the electrical domain and Cao specifies that the principal mode dispersion is corrected in the optical domain, the two references teach away from each other. Further, modifying one with the teachings of the other

renders either reference unsatisfactory for its intended purpose. Therefore, the references may not properly be combined.

For at least the reasons stated above, independent claims 1 and 12 are distinguishable over the combination Bulow and Cao. Claims 2-4, 9, 13-16, and 21 depend from claims 1 or 12, directly or indirectly, and are rejected based on the combination of Bulow and Cao references. Therefore, for at least the reasons stated with respect to independent claims 1 and 12, dependent claims 2-4, 9, 13-16, and 21 of the First Group are also distinguishable over the combination of Bulow and Cao.

Claims 5-8, 17-18, and 23 depend from claims 1 or 12, directly or indirectly, and are rejected based on the combination of Bulow, Cao, and Fishman references. It is to be noted that the Examiner did not, and indeed cannot, rely upon Fishman to correct for at least the above-noted deficiencies of Bulow and Cao. Thus, both independent claims 1 and 12 are distinguishable over the combination of Bulow, Cao, and Fishman. Therefore, for at least the reasons stated with respect to independent claim 1, dependent claims 5-8, 17-18, and 23 of the

First Group are also distinguishable over the combination of Bulow, Cao, and Fishman.

Claims 10, 11, and 22 depend from claim 1 directly or indirectly, and are rejected based on the combination of Bulow, Cao, and Bergano references. It is to be noted that the Examiner did not, and indeed cannot, rely upon Bergano to correct for at least the above-noted deficiencies of Bulow and Cao. Thus, independent claim 1 is distinguishable over the combination of Bulow, Cao, and Bergano. Therefore, for at least the reasons stated with respect to independent claim 1, dependent claims 10, 11, and 22 of the First Group are also distinguishable over the combination of Bulow, Cao, and Bergano.

B. Second Group - Bulow and Cao Cannot Teach Or Suggest The Elements Of The Independent Claim 19

Independent claim 19 recites, in part, "a polarization mode dispersion compensator optically coupled to an input port and receiving an input optical signal … an output of said polarization mode dispersion compensator serving as an output of the polarization mode dispersion compensating system." It has

been clearly demonstrated above that Bulow cannot be relied upon to teach or suggest this feature. *See sections A.1 - A.3 above.*

It has also been demonstrated that combination of Bulow and Cao references is improper since the references teach away from each other and render each other unsatisfactory for its intended purpose. *See section A.6 above.*

In addition, claim 19 is distinguishable for at least the following reasons.

B.1. Bulow Cannot Teach or Suggest the Q Detector as Claimed

Independent claim 19 recites, in part, "a Q detector operatively coupled to the output of said polarization mode dispersion compensator, said Q detector outputting an electrical signal **representing an edge sharpness** of the optical signal **output** from said polarization mode dispersion compensator."

In the Office Actions, the Examiner asserts that Bulow inherently teaches that a "Q detector" is coupled to the polarization mode dispersion compensator in that equalizing circuit 1.2 outputs a signal 1.15 representing the quality signal "Q" produced therein. *See April 1, 2004 Final Office*

Action, page 10, lines 4-7. The Examiner has simply and wrongly assumed that the similarities in terminologies "Q" and "quality" used in Bulow and in the claims mean that Bulow teaches the same.

Clearly, the output of the Q detector as claimed and the Q signal as disclosed in Bulow are different. As noted above, quality signal Q of the equalizing circuit 1.2 of Bulow which, at best, only represents the **error rates** of the polarization components of the signal **input** to the optical receiver.

There are at least two distinctions between the quality signal output from the Q detector as claimed and the quality signal Q of the equalizing circuit 1.2 of Bulow. First, the measure of quality of the signals are different. In claim 19 as recited, the quality is measured by the **edge sharpness** of an optical signal. This is to be contrasted with the signal Q of the equalizing circuit 1.2 of Bulow which measures quality by the **error rates** of an optical signal. The two simply cannot be equated with each other.

Second, in claim 19, the Q detector measures quality of the signal **output** from the PMD device. In contrast, the equalizing circuit 1.2 of Bulow measures the quality of the signal **input** to

the optical receiver. The two signals are completely different from each other.

Simply put, Bulow cannot be relied upon to teach or suggest a Q detector outputting an electrical signal representing an edge sharpness of the optical signal output from the polarization mode dispersion compensator as featured in claim 19 since the type of measurement and the particular signal measured are completely different between the claim 19 and Bulow.

B.2. Bulow Cannot Teach or Suggest the Controller as Claimed

Independent claim 19 recites, in part, "a controller operatively coupled to said Q detector and to said polarization mode dispersion compensator, said controller **receiving the electrical signal from said Q detector.**"

The operation of the controller as claimed in claim 19 is based on the input signals to the controller. It has been demonstrated above that the quality signal Q input to the control facility 1.3 representing error rates of the input optical signal components as disclosed in Bulow is completely different from the quality signal representing the sharpness of

edge pulses of the output optical signals. Thus, Bulow cannot be relied upon to teach or suggest the Q detector as claimed.

Then it logically follows that Bulow cannot be relied upon to teach or suggest the controller receiving the electrical signals from the Q detector as claimed in claim 19 since the information received by the control facility 1.3 of Bulow is completely different from the information included in the signals from the Q detector.

For at least the reasons stated above, independent claim 19 is distinguishable over the combination Bulow and Cao. Claim 20 depends from claim19, and is rejected based on the combination of Bulow, Cao, and Fishman references. It is to be noted that the Examiner did not, and indeed cannot, rely upon Fishman to correct for at least the above-noted deficiencies of Bulow and Cao. Thus, independent claim 19 is distinguishable over the combination of Bulow, Cao, and Fishman. Therefore, for at least the reasons stated with respect to independent claim 19, dependent claim 20 of the second Group is also distinguishable over the combination of Bulow, Cao, and Fishman.

IX. Conclusion

For the reasons specifically set forth above, the outstanding rejections set forth in the Final Office Action should be REVERSED.

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to Deposit Account No. 02-2448 for any additional fees required under 37 C.F.R. §§ 1.16 or 1.17; particularly, extension of time fees.

Respectfully submitted,

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APPENDIX

The Appealed Claims

1. A polarization mode dispersion compensating apparatus, comprising:

a polarization mode dispersion compensator optically coupled to an input port and receiving an input optical signal having polarization mode dispersion and a wavelength dither, said polarization mode dispersion compensator having a variable polarization mode dispersion, and an output of said polarization mode dispersion compensator serving as an output of the polarization mode dispersion compensating apparatus;

a polarimeter optically coupled to the output of said polarization mode dispersion compensator and outputting electrical signals representing polarization states of the output of said polarization mode dispersion compensator; and

a controller operatively coupled to said polarimeter and said polarization mode compensator, said controller receiving the electrical signals from said polarimeter, said controller controlling said polarization mode dispersion compensator according to the electrical signal to compensate for the polarization mode dispersion of the input optical signal.

2. The polarization mode dispersion compensating apparatus according to claim **1**, further comprising a signal source for generating the input optical signal with the wavelength dither, wherein the input optical signal is transmitted across optical fiber and/or components that cause the input signal to have the polarization mode dispersion.

3. The polarization mode dispersion compensating apparatus according to claim **1**, said polarimeter including:

a first polarizer optically coupled to said polarization mode dispersion compensator, said first polarizer plane polarizing the optical signal output from said polarization mode dispersion compensator at first polarization angle;

a second polarizer optically coupled to said polarization mode dispersion compensator, said second polarizer plane polarizing the optical signal output from said polarization mode dispersion compensator at a second angle different than the first angle;

a third polarizer optically coupled to said polarization mode dispersion compensator, said third polarizer circularly

polarizing ~~an~~ the optical signal output from said polarization mode dispersion compensator;

a first photodetector optically coupled to said first polarizer and outputting a first detection signal;

a second photodetector optically coupled to said second polarizer and outputting a second detection signal; and

a third photodetector optically coupled to said third polarizer and outputting a third detection signal.

4. The polarization mode dispersion compensating apparatus according to claim **1**, said controller controlling said polarization mode dispersion compensator so as to minimize a sum of the squares of the first, second and third detection signals to compensate for the polarization mode dispersion of the input optical signal.

5. The polarization mode dispersion compensating apparatus according to claim **1**, said polarization mode dispersion compensator including:

a polarization controller optically coupled to the input port and receiving the input optical signal;

a first birefringent component optically coupled to said polarization controller;

a variable retarder optically coupled to said first birefringent component; and

a second birefringent component optically coupled to said variable retarder, said controller being operatively coupled to said polarimeter, said variable retarder and said polarization controller, and said controller controlling said variable retarder and said polarization controller according to the electrical signal to compensate for the polarization mode dispersion of the input signal.

6. The polarization mode dispersion compensating apparatus according to claim **5**, said polarimeter including:

a first polarizer optically coupled to said second birefringent component, said first polarizer plane polarizing an optical signal output from said second birefringent component at an angle parallel to an optic axis;

a second polarizer optically coupled to said second birefringent component, said second polarizer plane polarizing

~~an~~ the optical signal output from said second birefringent component at an angle not parallel to the optic axis;

a third polarizer optically coupled to said second birefringent component, said third polarizer plane circularly polarizing the optical signal output from said second birefringent component;

a first photodetector optically coupled to said first polarizer and outputting a first detection signal;

a second photodetector optically coupled to said second polarizer and outputting a second detection signal; and

a third photodetector optically coupled to said third polarizer and outputting a third detection signal.

7. The polarization mode dispersion compensating apparatus according to claim **6**, said controller controlling said polarization mode dispersion compensator so as to minimize a sum of the squares of the first, second and third detection signals to compensate for the polarization mode dispersion of the input optical signal.

8. The polarization mode dispersion compensating apparatus according to claim **5**, wherein said polarization controller and said retarder are integrated electrooptic waveguide devices or liquid crystal components.

9. The polarization mode dispersion compensating apparatus according to claim **4**, said controller utilizing an adaptive learning algorithm to further minimize the sum of the squares of the first, second and third detection signals and further compensate for the polarization mode dispersion of the input optical signal.

10. A wavelength division multiplexed optical communication system, comprising:

a plurality of optical transmitters, each emitting a corresponding one of a plurality of optical signals, each of the plurality of optical signals being at a respective one of a plurality of wavelengths and having a respective wavelength dither;

an optical combiner having a plurality of inputs, each of the plurality of inputs being coupled to a respective one of

said plurality of optical transmitters, and an output supplying the plurality of optical signals to a first end portion of an optical communication path;

an optical demultiplexer having an input configured to be coupled to a second end portion of the optical communication path, and a plurality of outputs, each of the plurality of outputs of said optical demultiplexer supplying a respective one of the plurality of optical signals;

a plurality of polarization mode dispersion compensating apparatuses according to claim **1**, each of the apparatuses being coupled to a respective one of the plurality of outputs of said optical demultiplexer;

a plurality of optical receivers, each of the receivers being coupled to a respective one of the plurality of outputs of said polarization mode compensating apparatuses.

11. The wavelength division multiplexed optical communication system according to claim **10**, further comprising:

a plurality of optical amplification devices arranged in series along the optical communication path.

12. A method of compensating an input optical signal having polarization mode dispersion, comprising:

dithering a wavelength of the input optical signal so as to vary around a center wavelength;

compensating the polarization mode dispersion of the input optical signal with a variable polarization mode dispersion compensator, wherein an optical signal output of a polarization mode dispersion compensator serves as an output of a polarization mode dispersion compensating apparatus;

polarizing the optical signal output from the variable polarization mode dispersion compensator to generate polarized component optical signals;

detecting polarized component optical signals to generate detection signals; and

controlling said compensating step according to the detection signals.

13. The method of compensating an optical signal having polarization mode dispersion according to claim **12**, wherein:

said polarizing step includes subjecting the optical signal output from the variable polarization mode dispersion

compensator to plane polarization at a first polarization angle, plane polarization at a second angle different that the first angle, and circular polarization; and

said detecting step includes detecting the three polarized optical signals to output a first, second and third detection signals.

14. The method of compensating an optical signal having polarization mode dispersion according to claim **13**, wherein said controlling step includes controlling said compensating step according to the first, second, and third detection signals.

15. The method of compensating an optical signal having polarization mode dispersion according to claim **14**, wherein said controlling step includes minimizing a sum of the squares of the first, second, and third detection signals.

16. The method of compensating an optical signal having polarization mode dispersion according to claim **15**, wherein said controlling step includes adaptively learning to minimize the

sum of the squares of the first, second, and third detection signals.

17. The method of compensating an optical signal having polarization mode dispersion according to claim **12**,

wherein said compensating step includes:

changing principal polarization states of the optical signal;

inputting the optical signal from said controlling step to a first polarization mode compensating element;

retarding a phase angle of principal polarization states of the optical signal output from the first polarization mode compensating element; and

inputting the optical signal from said retarding step to a second polarization mode compensating element;

wherein said polarizing step includes subjecting the optical signal output from the variable polarization mode dispersion compensator to plane polarization at a first polarization angle, plane polarization at a second angle different that the first angle, and circular polarization;

wherein said detecting step includes detecting the three polarized optical signals to output a first, second and third detection signal; and

wherein said controlling step includes controlling said changing step and said retarding step according to the first, second, and third detection signals.

18. The method of compensating an optical signal having polarization mode dispersion according to claim **17**, wherein said controlling step includes minimizing a sum of the squares the first, second, and third detection signals.

19. A polarization mode dispersion compensating system, comprising:

a polarization mode dispersion compensator optically coupled to an input port and receiving an input optical signal having polarization mode dispersion, said polarization mode dispersion compensator having a variable polarization mode dispersion, and an output of said polarization mode dispersion compensator serving as an output of the polarization mode dispersion compensating system;

a Q detector operatively coupled to the output of said polarization mode dispersion compensator, said Q detector outputting an electrical signal representing an edge sharpness of the optical signal output from said polarization mode dispersion compensator; and

a controller operatively coupled to said Q detector and to said polarization mode dispersion compensator, said controller receiving the electrical signal from said Q detector;

said controller controlling said polarization mode dispersion compensator to minimize the Q represented by the electrical signal to compensate for the polarization mode dispersion of the input signal.

20. The polarization mode dispersion compensating system according to claim **19**,

wherein said polarization mode compensator includes:

a polarization controller optically coupled to the input port and receiving the input optical signal having the polarization mode dispersion;

a first birefringent component optically coupled to said polarization controller;

a variable retarder optically coupled to said first birefringent component; and

a second birefringent component optically coupled to said variable retarder;

wherein said controller is operatively coupled to said Q detector, said variable retarder and said polarization controller, said controller receiving the electrical signal from said Q detector; and

wherein said controller controls said variable retarder and said polarization controller to minimize the Q represented by the electrical signal to compensate for the polarization mode dispersion of the input signal.

21. The polarization mode dispersion compensating apparatus according to claim **1**, wherein said polarimeter detects said polarization states of the output of said polarization mode dispersion compensator in at least three degrees of freedom.

22. The wavelength division multiplexed optical communication according to claim **10**, wherein at least one polarization mode dispersion apparatus includes a polarimeter

configured to detect polarization states of an output of a corresponding polarization mode dispersion compensator in at least three degrees of freedom.

23. The method of compensating an optical signal having polarization mode dispersion according to claim **12**, wherein said polarizing step includes generating the polarized component optical signals in at least three degrees of freedom.